Fault Avoidance in Microelectronics by Pulsed Laser Irradiation

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OUTLINE

- Motivation
- Laser Cutting
- Laser Linking
- Future Research

EQUIPMENT

- XRL 525 Laser Processing System

$\longrightarrow$ 2 to 7 μm programmable elliptical spot

$\longrightarrow$ $\approx$ 100 laser operations per second

$\longrightarrow$ $\pm$ 1.0 μm positioning accuracy

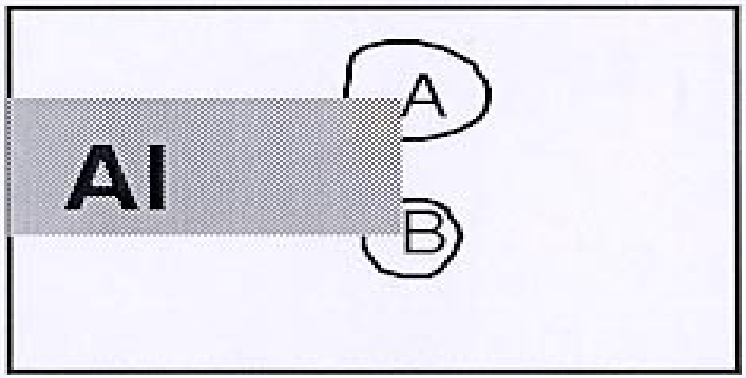
$\longrightarrow$ $\pm$ 1% energy delivered

- FEI Dual-Beam Focussed Ion-Beam tool (Profs. Orloff and Melngailis in EE department)

- Karl Suss Automatic Wafer Probe Station (Prof. Ramesh in NUMA)

Theory

- Stress in the Upper Corner is greater than in the lower corner

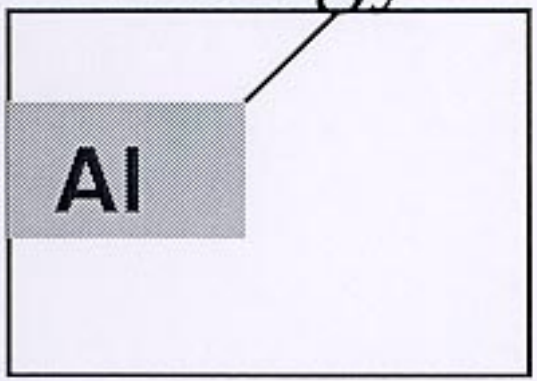


(cross-section)

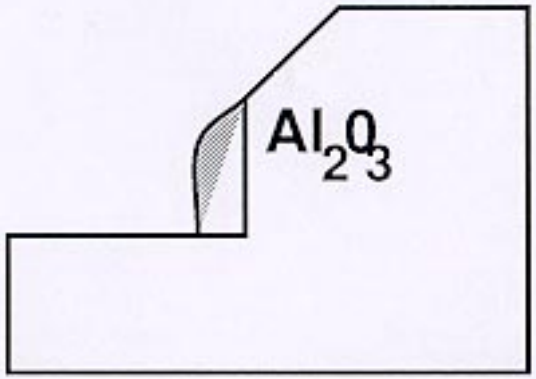
The Top fractures at a lower energy than the Bottom, thus removing the passivation

Laser Cut Evolution

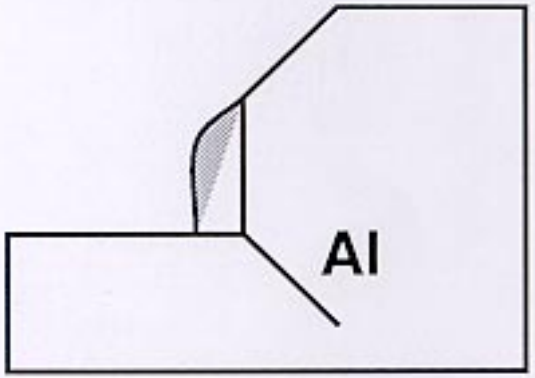
- Low Energy



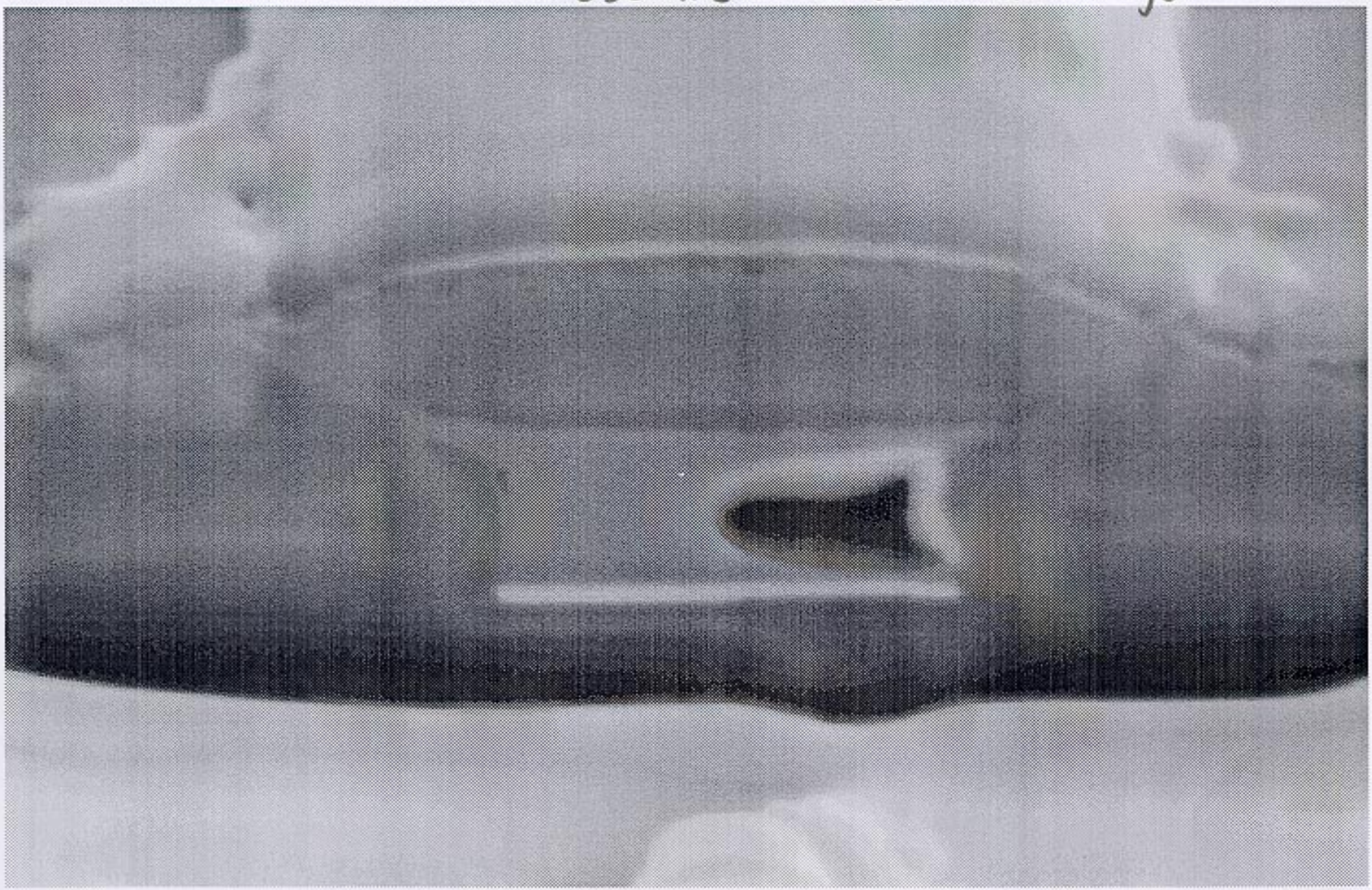
Ideal



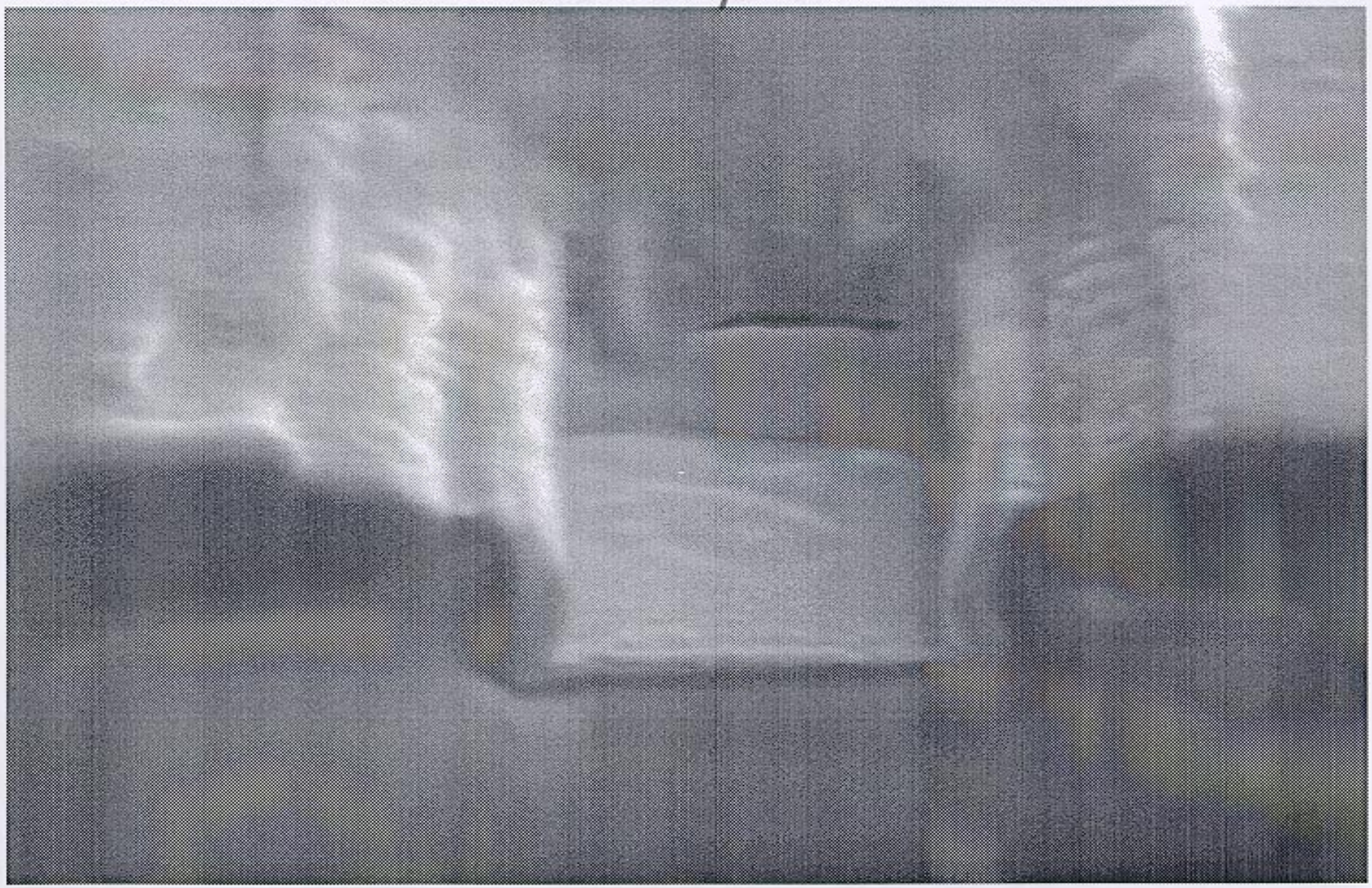
Too Much



330 nJ : Medium Link Range



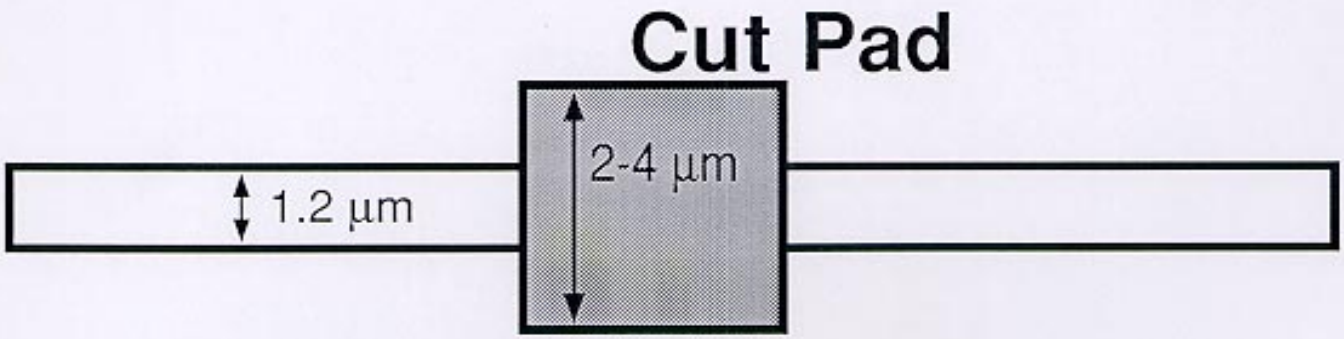
1.2 mJ



1.6 mJ : Lower Crack Forms

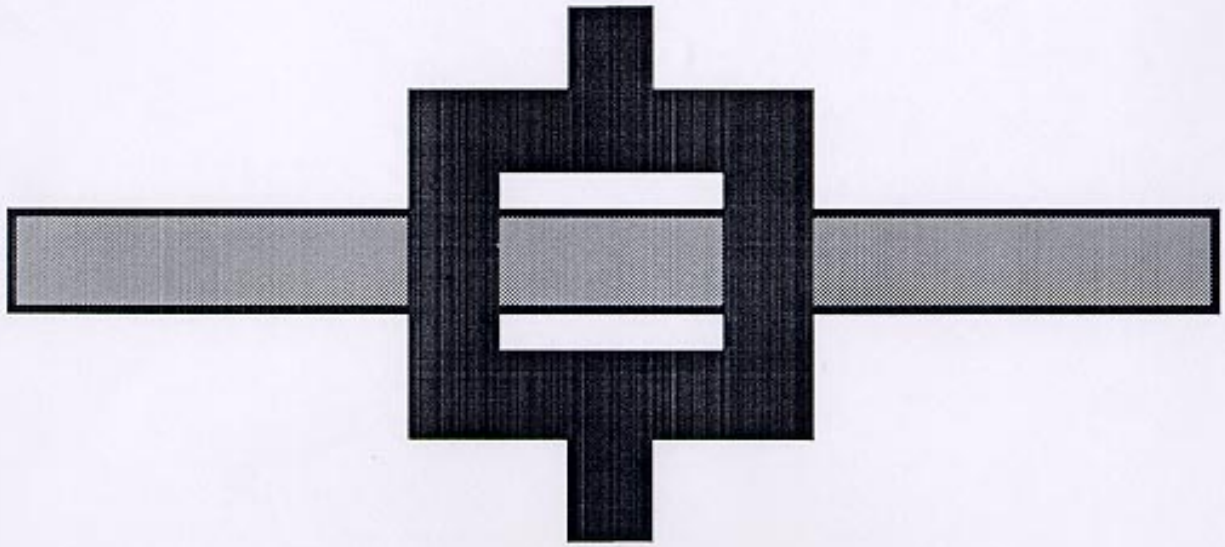
Proposed Cut Structure

- Wider metal for a more Reliable Cut
- Laser energy is absorbed where it is needed to cut the line
- Better removal of passivation



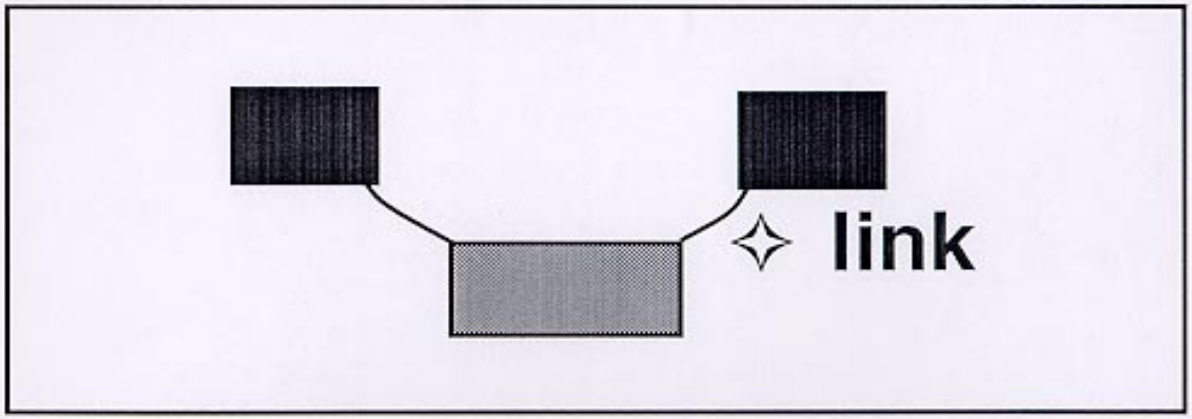
Improved Vertical Link

- Place Opening outside the edge of the lower metal



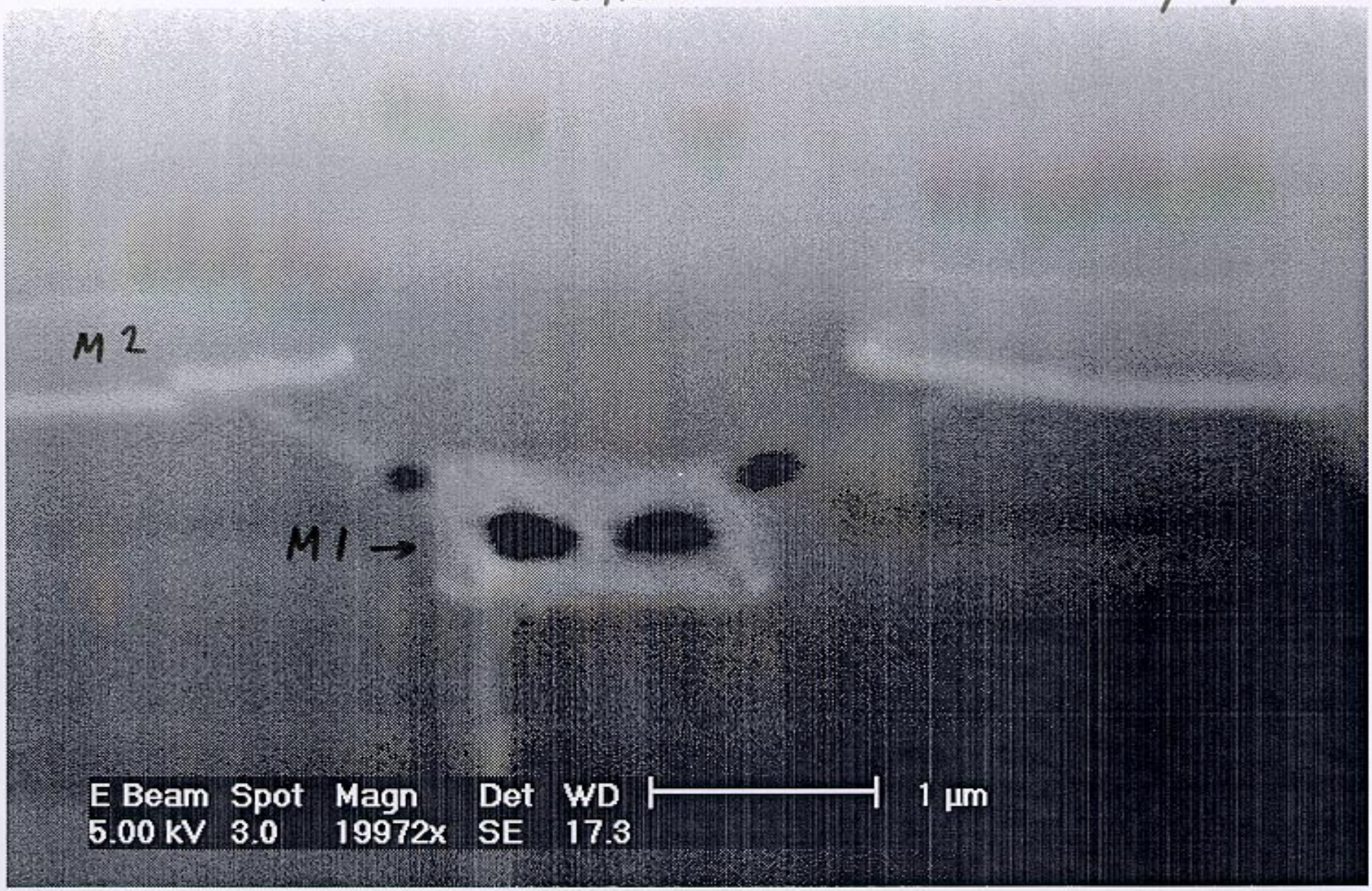
Advantages

- Wider Energy Window
- Double Sided Redundancy



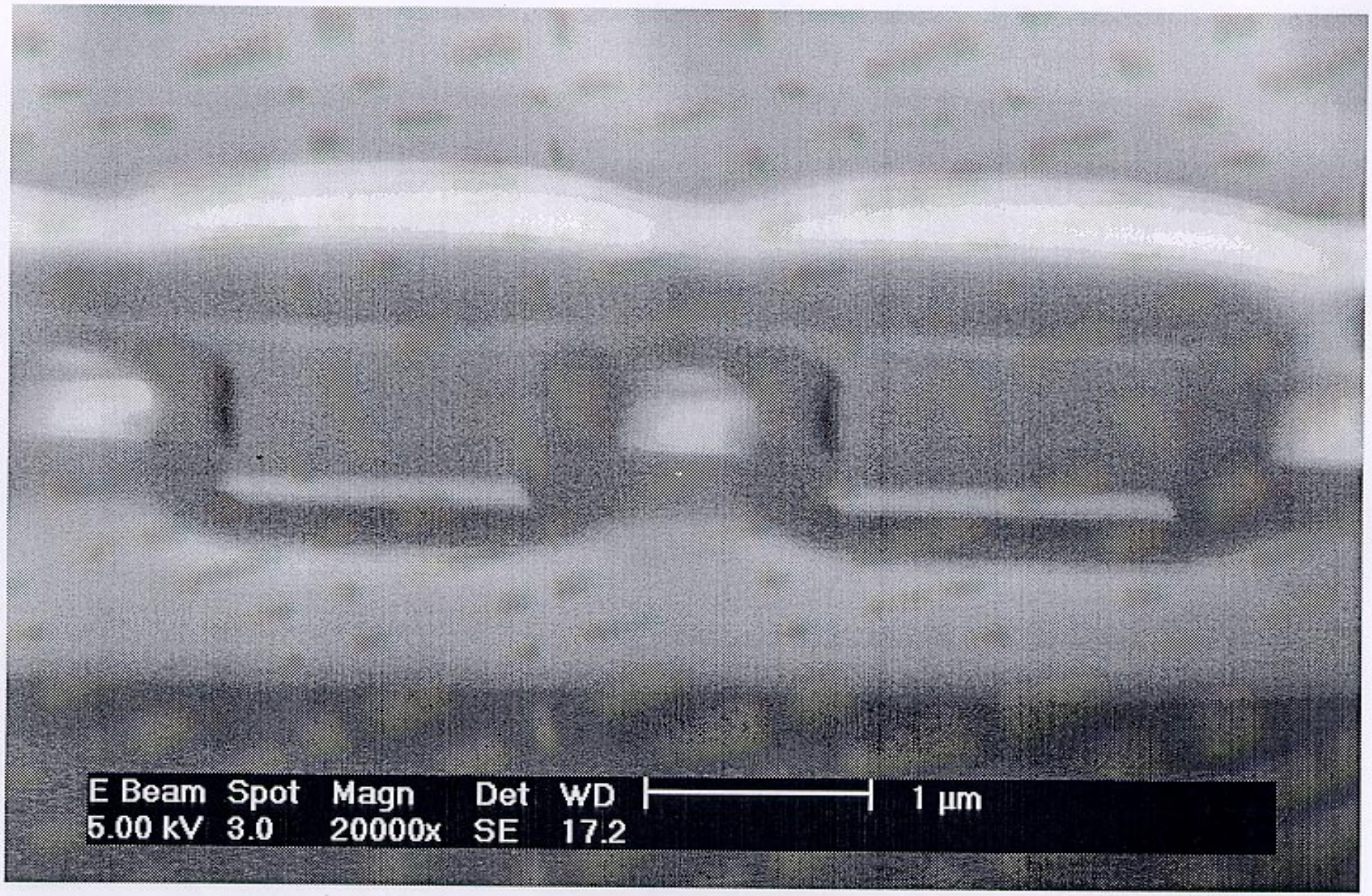
- Vertical Link Design included on JB051A test chip

450 nJ Vertical Link with Round 2.2 μm Spot



Advantages of Vertical Link

- NO Via Requirement
  - Link forms the via
- Self-Terminating Cracks
- Wider Process Window (with finer positioning accuracy)
- Scalable to MCM and WSI Dimensions


E Beam Spot Magn Det WD
5.00 kV 3.0 20000x SE 17.2
1 µm

Summary

- Confirmed New Cut-Failure
- Developed Fracture Criterion approach to laser links and cuts
- Used simulation to design new Link and Cut structures
- Proven Validity of Vertical Links
- Completed JB051A Test Chip

Future (FY-98)

- Develop Vertical Laser Links for WSI and MCM production
- Analyze the effects of process changes with respect to linking and cutting (CMP, W plugs, etc.)
- Maintain failure analysis for laser processing facility in R-141
- Develop new and innovative applications of laser processing